Emergency Report No. 1.

Medical Research Council
Industrial Health Research Board

INDUSTRIAL HEALTH IN WAR

A Summary of Research Findings capable of Immediate Application in furtherance of the National Effort

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MEDICAL RESEARCH COUNCIL
INDUSTRIAL HEALTH RESEARCH BOARD

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TERMS OF REFERENCE

To suggest problems for investigation, and to advise upon or carry out schemes of research referred to them from time to time by the Medical Research Council, undertaken to promote better knowledge of the relations of methods and conditions of work to functions of the human body, having regard both to the preservation of health among the workers and to industrial efficiency; and to take steps to secure the co-operation of industries in making widely known such results of this research work as are capable of useful application to practical needs.

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PREFACE

The Industrial Health Research Board is part of the organisation of the Medical Research Council (under the Committee of Privy Council for Medical Research). It was formerly called the Industrial Fatigue Research Board, and was first appointed in direct succession to the Committee on the Health of Munition Workers set up during the last war. The work for which the Board is responsible is defined in its terms of reference on page ii.

One of the lessons learned in the last war was that excessive hours of work do not ultimately pay—even when considered solely on the basis of output and apart from the effect on the health of the workers. Some of the earliest investigations undertaken by the Board were concerned with hours of work under various conditions, including the optimum length of spell and the effect of rest-pauses. The results were published in the Board's reports and are well known to progressive employers.

Since then, under the direction of the Board, many researches have been promoted into the human problems of modern industrial conditions. The results of these have also been published and are becoming known. *The need at the moment is rather for application of knowledge previously gained than for new researches*—although fresh problems for investigation may present themselves as the war proceeds. Practical application of the results is of course not the direct responsibility of the Board, but the advice of the Board and its staff is available to Government Departments and industrial organisations concerned with war-time production.

Advice has in fact already been sought by several Government Departments engaged in promoting the production of war material or in conserving man-power.

The Home Office is directly represented on the Board, and the Home Secretary stated recently in Parliament: "......Special observation, however, will be kept, in consultation with the Industrial Health Research Board, on the working conditions of women and others in factories during the war."

The results of twenty years' work were reviewed in the Eighteenth Annual Report of the Board, and special attention was drawn to such of the proved results of investigations as had already found a place in industrial practice or were ripe for practical application.

The present moment seems to the Board timely to express in simpler form those results which ought to be applied either at once or as soon as may be practicable. In the following sections, facts are stated in terms as simple and non-technical as the subject-matter permits. Where recommendations are made which may seem to war-time managers or employers to be impracticable or to need further research before they can be applied, or where new problems seem to present themselves, the Board hope to be consulted at the earliest possible moment.

For those who may wish to read for themselves original evidence in support of statements made in the following pages, a list of the Board's reports is appended for reference.

15*th March*, 1940.

INDUSTRIAL HEALTH IN WAR

A Summary of Research Findings capable of Immediate Application in furtherance of the National Effort

By the Staff of the Industrial Health Research Board of the Medical Research Council

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I—WORK AND FATIGUE

"*The country cannot afford the extravagance of paying for work done during incapacity from fatigue, just because so many hours are spent on it. . . . . Misguided efforts to stimulate workers to feverish activity in the supposed interests of output are as useless as would be the cheers of partisans encouraging a long-distance runner to a futile sprint early in the race.*" (Quoted from the Health of Munition Workers Committee Interim Report, 1917.)

Hours of Work

In war-industry, output—and more output—is the chief demand, but the very urgency of the demand requires consideration of the means by which it may be attained.

During the war of 1914–18 an increase in the output of munitions became of primary importance. To this end hours of labour for men were increased, 70–90 hours a week being common and over 90 not infrequent. The assumption was that, if one unit of work could be done in one hour, then six could be done in six, twelve in twelve, and so on. A simple calculation would give the expected output per week, per month, per year. The actual results were found to belie this assumption, for output did not increase proportionately to time and effort expended. Other disturbing symptoms appeared; for instance, sickness absence increased. The calculations had gone wrong—the worker had been mistaken for a machine.

To deal with this problem the Health of Munition Workers Committee was set up "to consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops."

It is not in doubt that, within certain limits, an increase in the hours of labour will increase the output; in six hours more work can be done than in five or four. The *best length* of the working day or week is the problem. In simple terms, if nine hours' work produces nine times as great an output as does one hour, will ten, eleven and twelve hours produce ten, eleven and twelve times as much ?

A study of the output in munition factories during the last war showed that such was not the case. *A twelve-hour day produced no more than a ten-hour.* The following is a concrete example from the Committee's report :—

Reduction from 58·2 to 51·2 in the actual weekly working hours of a group of fifty-six men, engaged in the heavy labour of sizing fuse bodies, increased the total output by 22 per cent., as shown in the accompanying table.

Output of Men Engaged in Heavy Work

	Average weekly hours.		Relative hourly output.	Relative total output.
	*Nominal.	*Actual.		
First period	66·7	58·2	100	100
Second period	62·8	50·5	122	106
Third period	56·5	51·2	139	122

Put in words, this table shows that :—

1. When the men actually worked 58·2 hours (nominally 66·7), the relative hourly output was taken as 100 and the gross production as 100.
2. When they worked 50·5 hours (nominally 62·8) the relative hourly output was 122 and gross production 106.
3. When they worked 51·2 hours (nominally 56·5) the relative hourly output was 139 and the gross production 122.

The Committee, in recommending reduction of hours, at the same time strongly recommended that the Sunday rest and ordinary holidays should not be interfered with.

Towards the end of the war, the Industrial Fatigue (now Health) Research Board of the Medical Research Council was set up to study this and kindred problems. In a number of trades, *e.g.* steel and iron, glass, shell-making, laundry-work, the following observations confirming the war experience have been made :—

(i) An extension of the usual hours of work does not—except for short periods during an emergency—give a proportional increase of output : on the contrary it causes the rate of output to fall off with increasing rapidity. It may be added that the working hours of women and young persons under 18 are controlled by law ; so that the main risk of over-long hours falls upon adult men, and particularly on the highly-skilled workers (tool and gauge-makers, tool-setters, etc.) who, because they are difficult to obtain, are most often employed for long hours. In addition long hours involve strain on the management, the executive staff, and the foremen :

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* "Nominal" means the hours spent in the factory. "Actual" means the nominal hours of work minus time lost for various reasons, such as waiting for work.

(ii) After a continuous period of overtime, improvement in output rate does not take place for some time after the re-introduction of shorter hours :

(iii) An unbroken spell of four and a half to five hours is generally too long. Man must rest, even at work. In some kinds of work the man can pause to "stand easy" from time to time—or may have pauses thrust upon him, *e.g.* by having to wait for material; but *organised* rest-pauses have been proved much more effective both to efficiency and health. The number and duration of rest-pauses depend on the nature of the work, but as a rule rests of ten or fifteen minutes about the middle of the morning and afternoon periods have been found to give satisfactory results. In some cases a break of five minutes every hour has been found better.

Fatigue

Fatigue and Recovery

It is not necessary here to ask how fatigue may be defined, or even what changes take place in the muscular and nervous systems of the fatigued person. It is enough to face the hard fact that continuous activity on the part of human beings is associated with a gradually diminishing success in that activity. The stages at which full success is replaced by partial success and eventually by failure are not the same for everyone, nor constant for the same person. It is obvious that an individual full of vitality will carry on successfully much longer than the same individual when already wearied by overwork, even though the task and conditions remain the same ; and that the same individual will flag sooner on strenuous work than on lighter, and on work for which he (or she) could see little use than on work which is consciously known to be valuable. These facts are well known but are nevertheless neglected in practice. Fatigue as shown by a diminished output (either in quantity or quality) is affected by the amount of available energy, the nature of the work, and the attitude of the worker towards it. Anything that reduces the available energy of the worker, or his interest, will hasten the stage at which reduction of effective work begins to take place. Up to a point force of will, stimulated by some powerful motive, can call on reserve forces and resist the onset of fatigue, but this cannot be done indefinitely.

The basic problem, then, is one of health—health of mind and body—since the healthier and more contented the individual the more energy he has available.

Variations in Output

Assuming health and general well-being, it has been found that output, if measured in hourly periods, does not remain exactly at the same level each hour of the working day. The degree to which variation occurs will depend on the relative parts played in any particular job by the machine and the worker. Where the work is completely automatic, variations in output are negligible so long as the worker is at the machine ; in these circumstances, fatigue is often expressed in increased sickness absence, labour wastage and spoilt work. Where the work is not automatic the variations in output are considerable.

On the whole, in normal circumstances, output records follow the same general trend, namely, a gradual rise at the beginning of the day, a period of relative stability and then a fall towards the end. This seems to be common for most continuous human activity, whether manual or mental. The fall off at the end of the day, when it exceeds a normal amount, is a critical symptom to be diagnosed and treated.

Perhaps the commonest cause, as already stated, is that of long continued overtime without adequate rest or holiday ; but, even with reasonable hours, inadequate management may of itself set up fatigue conditions. The irritability of a director can be passed down from grade to grade of the management till the workers, in ignorance of the initial cause, receive the back lash. " Nothing you do can please him," is the burden of complaint, and a state of grumbling is set up which in the long run interferes with output. When to this are added long hours and a feeling of working against time, discontent can become serious. Sympathetic and understanding directors, controlling officers and foremen can by their very presence do an immense amount in the avoidance of undue fatigue.

Effects of Fatigue

Apart from the diminished accuracy and speed consequent upon a fatigued state, as experienced by feelings of weariness and disinclination to make an effort, there are well-known fatigue symptoms, *e.g.* inco-ordinated movements, organic disturbances, irritability, listlessness. Consciousness of these can distract a worker's attention from the work to himself. Since some of them are also associated with certain diseases, it is not difficult for a fatigued person to imagine he is ill ; the step to being ill is short.

The remedy for fatigue is rest, and if work has been within reasonable limits a night's rest may restore energy. Where fatigue has been prolonged, then even a limitation of the hours does not result in a normal output for a number of weeks ; and laboratory experiments also have shown that a disproportionate time is required after a period of continuous fatigue before there is a return to the earlier efficiency. It is as if a person who normally lived on income from a certain capital required extra money for an immediate purpose : he could draw on his capital, but later he would have less capital and therefore less income.

The Mental Aspect

The mental aspects of fatigue, *i.e.* diminished efficiency, weariness, and an appearance of listlessness, *may* be present when the work is light and hours normal. This condition is due not to the using up of reserve energy, but to lack of interest due to absence of change. Most human beings, unlike machines, prefer change. The use of conveyor or other synchronized and sectional methods of production, together with some modern methods of wage incentive based on time and motion study, have tended to reduce the opportunities for relaxation and change. Work becomes monotonous and the worker bored.

But this is not inevitable. A comparison of two factories doing the same repetitive work showed considerable differences in other ways. In the one the majority of faces expressed a dull acquiescence in existence, in the other good-humoured interest. In the one nobody in authority took any interest in the workers except as "hands," the building was cheerless and uncared for, there were no recognised rest-pauses, and the management lacked personality. In the other, the management was keenly interested in both workers and work, and in everything that would produce good work; the result was that the workers were themselves interested in the work and in its accumulation as the day wore on, in the expressed approval of the authorities, and in the various social activities binding one to another.

It must not be assumed that all workers find all processes boring. One worker will stigmatise a process as boring and find another interesting, whereas to the observer there is nothing to choose between them. It has been found that on the average about 26 per cent. of workers experience considerable boredom at repetitive work.

But boredom in necessary repetitive work may be mitigated by varying the conditions and the environment under which the repetition work is done, for example by recognised rest-pauses, by seeing that the machine does not outpace the worker, by training workers to do more than one job, by allowing singing or music in the factory or workroom, by arranging smaller groups within the main group and encouraging competitive team work, by selecting workers for routine work who are neither too intelligent nor too easily bored, and by allowing adequate opportunities for promotion.

If the same degree of intelligence were applied to the understanding of people as to the understanding of machines, an enormous amount of trouble due to wasted effort and boredom could be avoided.

Design of Machines

It is a truism that industrial machines are frequently not designed with an eye to the workers who have to operate them.

Various investigations have been made relating the movements and posture of the operator to the human energy expended, and as a result, improvements have been suggested in many machines commonly used in industry. Such improvements could usually be made cheaply and without much modification of the machine: for instance, the better positions for setting levers—one of the commonest mechanical aids in industrial work—so as to get the best pulling or pushing effect. Similarly, the most suitable load to be carried or lifted by women and young persons has been studied; and for heavier loads the best way, for instance, of loading and handling a wheelbarrow.

So also posture at work has been related to average physique; in estimating, for example, the most comfortable height for a working-bench.

Time and Motion Study

Time and motion study has been largely used in the endeavour to lessen the human cost of work.

Time study deals with the time taken to perform each particular operation, in order to fix a reasonable standard.

Motion study deals with the movements performed in any operation in order to eliminate the useless ones and to improve and co-ordinate the necessary ones.

Some prejudice against time and motion study exists, due to its results having been limited by some people to speeding up, for the purpose of rate-cutting, regardless of the physical or mental constitution of the worker. When, however, it is used to discover the unnecessary movements in some particular process, the faulty sequence of processes or the bad arrangement of tools or materials, the knowledge obtained is invaluable. By this knowledge the task of the skilled worker may be facilitated, and the learner taught by more profitable methods.

Workers develop a set of muscular habits on which their work is based. These are not always the most economical of human effort, but when the worker has become used to them it is as a rule difficult to attempt to change them quickly. "You cannot teach an old dog new tricks." It is different, however, with beginners. They can learn one set of movements as easily as another, and are quite willing to be taught the set that will cause them the least muscular effort.

In many organisations time and motion study specialists are appointed, sometimes for a limited period and sometimes as permanent members of the staff. In many of the simpler processes, however, it is possible for an intelligent foreman to be taught how to reduce much wasted effort. In one factory it was calculated that owing to the position of a table on which each finished article was placed, a girl walked twenty miles a week unnecessarily.

When, by studying experienced workers, a simpler method of doing the work has been devised, this should be taught to beginners. If the new method is based more on the natural rhythm of the worker, and avoids obstacles to the easy formation of simple muscular habits, output will be increased and the increase will be maintained.

Moreover, beginners will learn a new process in this way much sooner than if they were allowed to pick it up for themselves.

Considerable increases in output have been effected in various industries in this way without speeding-up. The increased output that is gained by studying the worker's movements and adapting the work to his rhythm is maintained, because the effort required of the worker in these circumstances does not cause more fatigue than he can recover from in his ordinary hours of work. The increase that is gained by forcing him to work at too great a speed is not maintained, because he cannot recover from the resulting fatigue during his ordinary hours of work : his fatigue, therefore, becomes cumulative.

During the present emergency it is of vital importance that these results of many years' research should be put into general practice. Many workers will be called upon to undertake new tasks necessitated by war-time requirements. If these new workers are taught from the first the least fatiguing way of doing their work, there can be little doubt that their output will be much higher than if they were allowed to pick up methods of doing it for themselves.

Unnecessary movements—or in some cases postures—are often due to faulty arrangement of the work. Thus the lay-out of a process should be studied, and arrangements made for the best means of delivery and removal of materials. Faulty movements, quite apart from irritation to the worker, may cause unnecessary fatigue.

Attention to the right height of bench, the most comfortable seating accommodation, and the use of the most handy kind of tools, is of equal importance.

Summary of Recommendations

(1) Avoid over-long hours and continuous work without intervals for rest.
(2) Allow Sunday rest and ordinary holidays.
(3) Take measures to alleviate boredom, *e.g.*, by varying the work and by providing distractions, such as music, that do not too greatly alienate the attention.
(4) Study the arrangement of the work to cut out unnecessary movements and effort.
(5) Keep an eye open for danger signals, such as increase in sickness absence, accidents and labour wastage.

II—LIGHTING AND VISION

There is a relation between good lighting and the efficiency as well as comfort and safety of the worker ; and as vision plays a large part in almost every human activity, its importance in relation to industrial performance is too obvious to need emphasis. What should be equally obvious, but is often inadequately appreciated, is that good vision cannot be effective without good lighting.

Lighting

Natural lighting, *i.e.* daylight, is ideal when there is enough of it. Since it is not available for night work and during many ordinary hours of work in winter, and since it has now been interfered with by "black-out" conditions, a satisfactory substitute or supplement is essential.

Essentials of Artificial Lighting

Good artificial lighting means both an ample *amount* of light for the task and a proper *distribution* of the light. Briefly its essentials are :—

(1) Enough light to make everything that is required to be seen bright enough to be seen *quickly* and *accurately*, at least by individuals possessing "normal" vision and with a margin of safety for subnormal eyes. The amount of light required depends on a number of objective factors, of which the most important are :—
  - (*a*) dimensions and distance of the relevant objects to be seen (controlling size of image at the eye) ;
  - (*b*) reflecting power, surface finish and form of objects (controlling brightness of image at the eye) ;
  - (*c*) contrast (of colour and/or brightness) between parts of objects and between objects and background ;
  - (*d*) movement of objects relative to the eyes (affecting time available for perception).

(2) Controlled distribution of light, to make the many different brightnesses in the field of vision form a picture comfortable to the eye. The distribution of light should be such that :—
  - (*a*) glare is avoided ;
  - (*b*) the surroundings as well as the work are well lighted ;
  - (*c*) there are no troublesome shadows.

These conditions are most likely to be satisfied if the planning of a new, or the modification of an old, installation for artificial lighting is entrusted to a specialist.

Effects of Inadequate Lighting

Inadequate illumination is a thief of time. It slows down, or renders uncertain, the process of seeing and increases the time between vision and performance. Production is affected both by a slower rate of working and by an increase of spoilt work. The liability to experience eyestrain, "nervous trouble," and accident is increased.

Investigations carefully made in a number of industries have clearly shown the effect of inadequate illumination on production. For example, compositors can fall short of their daylight output by more than 10 per cent.—and make considerably more errors—with an illumination which "looks good" and is adequate for many industrial tasks. The performance of rough work involving no discrimination of detail has also been found to be affected by illumination, and to a greater extent than is generally realised.

Standards of Lighting

Sufficient and suitable lighting in factories is now required by law. In 1938 the Departmental Committee on Lighting in Factories recommended that all interior working areas should be illuminated to not less than 1 foot-candle at floor level, and that the illumination should be not less than 0·5 foot-candle in other interior parts of factories over which employees are liable to pass.* It was emphasized that these are minimum values for general lighting, which do not represent the best practice. Nor is the minimum of 1 foot-candle for the general illumination of working areas sufficient for the doing of any but the roughest work. As the result of many investigations, including those made by the Industrial Health Research Board, the following ranges of illumination for broad categories of work are known to be consistent with a high standard of performance :—

For rough work, chiefly involving gross visual perceptions	2–4 foot-candles†
For medium work, involving discrimination of fairly small detail, not being in very low contrast or rapid motion ..	4–10 foot-candles
For fine and very fine work, involving small detail and/or low contrast and intensive visual application	10–100 foot-candles

The illumination provided in factories for work included in the first category is often very poor. It is almost as great a mistake to stint light for this as for other work more obviously dependent on good vision. As an example, performance of the rough work of tile pressing, for which little more than half a foot-candle was provided, has been shown to improve progressively with increase of illumination up to twenty times this value. The economic optimum is, however, from 3 to 4 foot-candles. Here, good lighting is beneficial not only by increasing visual capacity, but because it helps to maintain a cheerful environment.

The second category includes the largest number of industrial tasks. Examples are engineering machine shop operations, medium assemblies and bench work, weaving light coloured cloth, and ordinary clerical work.

For the third category, high illumination is essential. Instrument making, type-setting by hand, sewing on and weaving dark material, and assembling radio valves, are a few examples.

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* Fourth Report of the Departmental Committee on Lighting in Factories. *H.M. Stationery Office*, London, 1*s*.

† The foot-candle is the unit of measurement of illumination in this country. An illumination of one foot-candle is produced by a standard candle at any point on a surface one foot distant, and so placed that rays from the light source meet the surface at right-angles.

General and Local Lighting

A good lighting installation should ensure general illumination of the whole workshop to a level not much below that necessary for the work itself. Thus, where local lighting is necessary, the higher the illumination required on the work the higher should be the general illumination also. Usually the ratio of local to general illumination should not exceed 10 to 1. Considerable diversity of illumination within the workship necessitates frequent changes of adaptation of the eyes. These cannot be effected instantaneously; hence delays in seeing occur, with consequent waste of time and increased risk of accident. Further, dark surroundings, by limiting visual capacity, in effect reduce the illumination of the work.

In many workshops, particularly where no fine work is done and structural impediments are few, a system of general lighting only is usually sufficient. But for very fine work supplementary local lighting is always necessary, and can be achieved by means of adequately screened light sources on adjustable mounts. Adjustability is important, since one man may need more light than another for the efficient performance of fine work. Thus, recent investigation has shown that the "average" worker in a group performing an exacting visual task may require twenty times the light required by the "best" worker in order to reach the same level of performance.

Lighting Equipment

All artificial light sources should be equipped with fittings designed to ensure a suitable distribution of light, and to protect all workers from glare while working or moving about the factory. Direct glare is doubly wasteful, because the light producing it illuminates nothing required to be seen, but only the eyes themselves, while it impairs visibility of the work and causes discomfort. Shadows due to the ill-considered placing of light sources, or of movable obstructions, also represent a waste of light and loss of seeing capacity.

Proper maintenance of the equipment for artificial lighting is clearly important. In some industries accumulation of dirt on lamps and fittings can quickly cause the loss of as much as 40 per cent. of the light paid for, and lead to a reduction of work output. Similarly, window cleaning at appropriate intervals is essential for the fullest utilisation of daylight. Where windows are blacked-out, whether permanently or only at night, the inside of the windows, blinds or shutters should preferably be light in colour. Thus, a considerable portion of the artificial light usually lost by transmission through windows will be reflected to the interior, and enhance the brightness of the factory. Clearly the amount of light conserved in this way will be greater the higher the ratio of window to wall or roof area, and hence (as partial compensation) greatest when the cost of blacking-out is highest.

Vision

Apart from complaints due to really bad lighting, complaints of difficulty in seeing often come from those who suffer from bad eyesight, or who are employed on such fine work that the best of lighting would not eliminate eyestrain. Slight defects of the eyes are common, but unlikely to be troublesome unless lighting is really bad or prolonged fine work has to be done. If the latter is the case, examination by an oculist and, when possible, correction of the defect by spectacles or other means is the obvious remedy.

Persons engaged on very fine work are specially liable to experience eyestrain and loss of efficiency—even if their sight is "normal" and the illumination of their work is very good. To meet the needs of these, various optical aids to vision are available. Thus, industrial magnifiers, consisting of mounted lenses of suitable size, can be interposed between the eyes and the work. If desired, these can be bought combined with local light sources. Various forms of binocular magnifiers are also available for individual use in conjunction with any correcting glasses usually worn. Alternatively, special glasses can be prescribed which combine any necessary correction for errors of refraction with lenses and prisms which considerably reduce the strain to which the eyes are subjected in doing close work for lengthy periods. As a result of the Board's work, such glasses have been introduced in a number of factories with beneficial results to the workers and appreciable improvement of their performance (see I.H.R.B. Reports Nos. 40, 49 and 57). There need be no fear that the use of these glasses, if properly prescribed, will involve any undesirable consequences, such as deterioration of vision or dependence on glasses for ordinary seeing.

The glasses themselves are useless except for their special purpose, since they greatly restrict the range of vision. For this reason, if they are designed to be worn close to the eyes as are ordinary correcting glasses, flat-topped lenses can be used so that distant vision is possible by looking over the tops, thus avoiding the nuisance of frequent removal.

Summary of Recommendations

(1) Good factory lighting, which is necessary for efficient working, safety and comfort, involves :

- (i) sufficient illumination, namely from 2 to 100 foot-candles or more, according to the nature of the work ;
- (ii) proper control and distribution of light to ensure the absence of glare, of troublesome shadows and of dark surrounds.

(2) Good vision on the task, which is equally necessary, involves :

- (i) good lighting, as above ;
- (ii) correction of eye defects ;
- (iii) special optical aids for very fine work.

III—HEATING AND VENTILATION

The Influence of Temperature

Lack of warmth on the one hand, and overheating on the other, cause discomfort. Experience gained during the last war, and by investigations made since, has shown the extent to which the efficiency and well-being of the industrial worker can be adversely influenced by unsuitable atmospheric conditions.

Efficiency and Temperature

Productive efficiency falls when the temperature rises unduly—particularly in heavy occupations. Output statistics show that in hot industries such as iron and steel, tinplate and glass manufacture, the rate of production is least in the hot summer weather and greatest in winter. In some cases the output in the summer quarter has been found to be 10 to 15 per cent. below that in the winter quarter. In badly ventilated tinplate works this seasonal variation was found to be considerably greater than in well ventilated factories. In coal-mining, too, working capacity is affected by temperature. From observations made on coal-miners it was calculated that as the temperature rose from 63° to 89° F., the working efficiency of the miners fell by 41 per cent. It has also been demonstrated that in the lighter work of textile operatives the efficiency deteriorates as the temperature rises above the comfort zone.

On the other hand, low temperatures adversely affect manual dexterity; and in industry, especially where metal parts are handled, temperatures below the comfort zone undoubtedly decrease efficiency in operations requiring much dexterity.

Accident Frequency and Temperature

In certain munition works during the war of 1914–18, the number of cuts and minor accidents was at a minimum when the shop temperature was 65° to 69° F., and rose considerably when the temperature was much below or above that range. In coal mines the accident rate was found to increase as the temperature became uncomfortably high.

Requirements for Satisfactory Heating and Ventilation

Broadly speaking, those atmospheric conditions which are generally found to be comfortable are also those which are best from the standpoint of efficiency and safety.

Any system of heating and ventilation has first to ensure an adequate supply of chemically pure fresh air. After that, attention has to be paid to the temperature, humidity, and rate of movement of the air, and to radiation from the solid surroundings (*e.g.*, walls, machinery and heating appliances). These factors together affect the feeling of warmth, and determine whether the air seems fresh or stuffy, invigorating or oppressive.

Fresh Air Supply

Wherever possible, ventilation at the rate of not less than six air changes per hour is to be aimed at; *i.e.*, the volume of fresh air entering the room each hour should be equal to six times the volume of the room. In winter this standard may sometimes be impracticable on the ground of heating costs, but in any case a rate of fresh air supply much below 1,000 cubic feet per person per hour is inadvisable. If much gas is burnt, or unpleasant fumes are dissipated in the room, higher ventilation rates may be necessary. In certain industries where dust or poisonous fumes and gases are produced, detailed requirements for their control are laid down by the Factories Act or by regulations for the dangerous trades: the question is therefore not dealt with here.

Air Temperature

For individuals doing light work, the air temperature in winter should be as nearly as possible 65° F. It is undesirable that it should fall below 60° or exceed 68° F. (The Factories Act, 1937, Section 3, requires that in rooms where a substantial portion of the work is done sitting and does not involve serious physical effort, the temperature *must not* be below 60° F. after the first hour of work). For more active work somewhat lower ranges of temperatures suffice—*e.g.*, for active yet light work a temperature of from 60° to 65° F., and for work necessitating more muscular exertion, a temperature between 55° and 60° F.

In hot weather it will generally be impossible to keep factory temperatures down to the maximum values suggested for winter, nor are such temperatures desirable in very warm weather. With adequate ventilation it should be possible to maintain a shop temperature in summer only slightly above the outside temperature.

The temperatures mentioned above are those which will generally be found comfortable. In the interests of efficiency, overheating should be avoided.

With some methods of heating (*e.g.*, overhead steam pipes), the temperature of the air at head level is often found to be much higher than that near the floor. This tends to produce a feeling of stuffiness in the head while the feet are cold. Such a result may be avoided by increasing the air circulation and thus mixing the air at different levels.

Radiant Heat

In winter the internal surfaces of the walls and roofs of lightly constructed buildings may be several degrees cooler than the general air of the shop. Owing to the radiation of heat from their bodies to these cold surfaces, persons working near such walls may need some extra radiant heat or a rather higher air temperature. In other cases, where considerable radiant heat is given off from heating apparatus or manufacturing plant, it may be desirable to reduce the air temperature or to increase the rate of air movement.

Air Movement

During the winter season, the air velocity in the ordinary factory is usually greater than 20 feet per minute and generally averages about 30 feet per minute. In summer weather, velocities distinctly higher than these are desirable. At velocities much below 20 feet per minute the air tends to seem dead and feelings of stuffiness are likely to arise, especially when the temperature approaches the upper limit of the comfort zone. Adequate air movement is necessary to provide an invigorating atmosphere.

Satisfactory air movement will generally be secured in rooms ventilated by suitably placed windows, when proper use is made of these. Where mechanical ventilation is installed, good air movement can be ensured if due care is given to the design and placing of air inlets and the velocity of discharge therefrom.

Atmospheric Humidity

Even at ordinary room temperatures a high humidity tends to induce feelings of stuffiness. At such temperatures the moisture content of the air should not exceed 70 per cent. of the saturation value and should preferably be well below that figure. In the average factory, where there are no wet processes, the humidity will generally be satisfactory if the fresh air supply is adequate.

At high temperatures, high humidities cause great discomfort and may even be injurious to the worker. Therefore, in rooms where there is abnormal humidity, wet and dry bulb thermometers should be provided and the temperature and humidity kept under observation. Discomfort is generally felt when the wet bulb temperature exceeds 70° F. (Under the Factories Act, 1937, and the Cotton Cloth Factories Regulations, there are special requirements which apply to any room in which a textile process is carried on and into which artificial humidity is introduced.) Where high humidity is unavoidable, its effects can be considerably mitigated by promoting vigorous air movement.

Ventilation Arrangements

Natural Ventilation

Large and suitably placed windows of the centrally-swung and hopper types are sufficient to secure the adequate ventilation of narrow buildings. In wider single-storey buildings, large, modern roof outlet ventilators in addition to windows may be necessary to secure sufficient ventilation. Openings for natural ventilation should be of generous size and suitably placed. It is a useful working rule to require not less than 5 sq. ft. of ventilation opening per 100 sq. ft. of floor area.

Mechanical Ventilation

As is now well-known, many workrooms—especially extensive single-storey factories—cannot be satisfactorily ventilated by natural means ; correctly planned systems of mechanical ventilation, involving the use of fans, are then necessary. In such cases the design of the heating arrangements should be considered in relation to the ventilating system adopted, and the advice of competent heating and ventilating engineers should be sought.

Ventilation in " Black-out " Conditions

In factories ventilated by mechanical installations, the war-time lighting restrictions are unlikely to interfere with the ventilation arrangements, but difficulty will probably be experienced—and is, in fact, being experienced—in those where reliance is placed on natural ventilation. The complete screening of windows and sky-lights will necessarily reduce ventilation to an undesirably low level unless special provision is made for the entry and exit of air.

In the winter months, even where only a day shift is worked, the period during which lights must be screened is long enough to allow considerable deterioration of atmospheric conditions when ventilation is restricted on account of lighting precautions. In factories, therefore, where ventilation has been interfered with by " black-out " conditions, special provision for ventilation is urgent as a preventive measure lest the efficiency and comfort of the workers should become impaired. Where a night shift is worked, arrangements for securing adequate ventilation are even more imperative.

A ready method of providing the needful ventilation is by introducing some mechanical system. This may take the form of extraction fans suitably placed on the external walls or in window frames. With proper arrangements for the admission of fresh air, *e.g.*, window frames replaced by, or adjusted to, a form of "light-trap," such a scheme should be reasonably good provided that workers in the neighbourhood of the inlets are not subjected to unpleasant draughts, and that the openings are yet of sufficient size and so placed that a good circulation of air is ensured.

Perhaps a more suitable method, except for low-ceilinged rooms, is the use of fans so arranged as to pass fresh air from outside over a heating surface (*e.g.*, a steam radiator) and thence propel it forward into the room. It can be arranged that these fans either take their air supply directly from outside or re-circulate the air of the factory, as desired. They should be able to discharge large volumes of air at a temperature not very much above that of the factory. Properly used, such fans set up stimulating air currents without giving rise to draughts at working level.

Where the installation of mechanical ventilating devices is impracticable, it should be possible in many cases to contrive a reasonable, if not very large, amount of natural ventilation by arranging suitable screening. Factory windows vary in pattern so much that it is not possible here to describe in detail the methods which can be applied ; but in most workrooms, by the exercise of a little ingenuity, it should be possible to arrange for some method of screening which will permit of the passage of air without infringing the lighting regulations. (Various ventilator light traps are described in Standard Specification BS/ARP/31, shortly to be published by the British Standards Institution.)

Supervision of Appliances

The ventilation and heating of a factory should be under the effective supervision of some person or persons on the staff who will pay special attention to the proper use of the appliances and arrangements provided. Particular care should be taken to ensure that :—

(*a*) the temperature is suitable for the work performed, and that overheating is avoided ;
(*b*) there is adequate air movement ;
(*c*) there is a sufficient supply of fresh air ; and
(*d*) where for any reason the humidity is likely to be high, a close watch is kept on the wet-bulb temperature.

Unduly low temperatures at the beginning of the day, and excessive warmth later, are still too often observed. These troubles could usually be removed by adequate supervision.

Summary of Recommendations

The chief requirements for satisfactory heating and ventilation are :—

(1) The temperature should be suitable for the work that is to be performed.
  (i) In winter suitable temperatures are :
    for very light work, 65° F. ;
    for active yet light work, 60° F. to 65° F. ;
    for work involving more muscular exertion, 55° F. to 60° F.
  Overheating should be avoided.
  (ii) In hot weather the temperature should be kept as low as possible by thorough ventilation.
(2) The supply of fresh air should be not less than about 1,000 cubic feet per person per hour, and should preferably be greater. " Black-out " arrangements should not be allowed unduly to restrict ventilation.
(3) Adequate air movement should be ensured. In winter the rate of movement should be about 20 to 40 feet per minute, and in warm weather higher velocities are desirable.
(4) The relative humidity should not generally exceed 70 per cent. and should preferably be distinctly less. Proper ventilation will usually ensure that the air is not unduly moist.

IV—ACCIDENTS

Accident Causation

The present day extensive mechanisation of industry leads to numerous accidents—fatal, disabling, or slight. For years past efforts have been made by the Home Office and various non-official organisations to reduce accidents by guarding machinery and improving environmental conditions and by warning the workers ;

but in the Annual Report of the Chief Inspector of Factories for 1918 it is stated that "however well machinery may be guarded, we cannot look for more than a 10 per cent. reduction in the accident rate by the provision of safeguards alone," *i.e.*, it was recognised that of the accidents then occurring only a small proportion could be prevented by action beyond the control of the worker. This quotation implies that *even if every machine has been made as far as possible fool-proof, there will still be many accidents.* At this time it is more than ever necessary to have within factories an efficient safety organization to deal with accidents, and to apply in their prevention the results of many years of study devoted to the conditions influencing their causation, about which much is known. They are discussed below :—

(1) The external or impersonal conditions relating to the material used, to the machine, or to the speed of the machine. This aspect has for long received considerable attention from the side of the law, from the makers and users of the machines, and from safety officers and others.

(2) The general environmental conditions, such as temperature, lighting and hours of work. It has been found that minor accidents are relatively frequent at low and high air temperatures, but relatively few at intermediate temperatures ; the actual temperature most suitable has been found to depend on the nature of the work (see Section III). During periods of artificial lighting an excess of 26 per cent. in accidents has been reported. When a twelve-hour day (75 hour week) was being worked, the accidents were 2½ times as many as when the working day was reduced to 10 hours.

(3) Accidents in factories are known to increase considerably with an increase in the number of inexperienced workers. During war, many factories will of necessity have to employ more inexperienced workers than before, and if accidents are to be avoided more adequate supervision will be needed.

(4) Although age and inexperience are closely associated, it is known that a group of young people will be more likely to sustain a higher accident rate than a group of older people equally inexperienced. Certain qualities of youth, *e.g.* failure to realise danger, tend to disappear with increasing age.

(5) Personal variations of a temporary nature (see Section I). Fatigue, lack of sleep, and minor sicknesses, have all been found associated with a high accident rate.

(6) A personal susceptibility inherent in some individuals. The existence of this quality has been suspected for centuries (*cp.* the phrase "all thumbs") but has now been established statistically, not only for industrial risks, but also

in the home and on the road. Thus, it will be found that if a large number of individuals are exposed to the same risks, 75 per cent. of all the accidents occurring among them happen to a small minority of the group, possibly consisting of as few as 10 per cent. of its number—in plain language to the " all thumbs " people. These have been labelled " accident-prone." Their " proneness," moreover, is independent of any question of responsibility or blame. They sustain not only an undue number of accidents both in the factory and out of it, but those who suffer from an undue number of one kind of accident fall victims to accidents of other kinds..

This personal susceptibility is a quality that is never lost, so that persons who sustain an undue number of accidents in one period of exposure will tend to do so in other periods of exposure. Further, those who have an undue number of *minor* accidents also tend to sustain an undue number of *major* accidents. Though these individuals are relatively few in number, their accidents are numerous: to detect them, and to remove them to safer places, would thus have a big effect on accident reduction.

Prevention of Accidents

The prevention of accidents will depend upon the cause, and where there is a high accident rate a detailed study of all possible causes is called for.

Machines of a dangerous kind must, by law, be properly guarded. They should, where practicable, be timed to run at regular, known and optimum speeds.

Equally, the environmental conditions need attention, and while in war-time the problem of lighting is (as already pointed out) relatively less easy, yet it cannot be neglected. Accidents may be caused not only by too low an illumination, but also by too great a variation in illumination. When the worker turns his eyes from a brightly lighted bench to a poorer light, his eyes may have insufficient time to adapt to the lower conditions of illumination. He becomes temporarily blind, and in the short period before adaptation has taken place, he is liable to accident (see Section II).

Temperatures are not always adequately regulated ; it is common to find factories where full use is not made of the plant that has been installed for regulating the temperature.

In groups consisting of inexperienced or young workers the accident rate can best be minimised by careful supervision.

The temporary personal variations will need the co-operation of both managers and employees. In this field great use can be made of the industrial medical officer and of the welfare worker. As regards the accident-prone, there are two ways of preventing them from running into danger—first, on the basis of appropriate tests that will determine beforehand those who are most likely to sustain accidents; secondly, by removing those who in an initial period of exposure sustain an undue number of accidents.

In respect of the first method tests have been devised, and it is known that those who fail at them subsequently suffer an undue number of accidents. But these tests need apparatus and an experienced tester, and can be given only to one person at a time. In war, therefore, they are hardly practicable. The second method is more practical, *i.e.* to remove from the more dangerous departments those who sustain a disproportionate number of accidents, however trivial. A department may be considered less dangerous if the average accident rate is lower, or if the type of accident the workers are exposed to is less serious.

Accident Records

Seeing that the effects of minor accidents in the aggregate are far from negligible, it is advisable that a record of all accidents, however trivial, should be kept. They can be entered on the same form or card as is used for sickness absence and labour wastage (see Section V).

Assuming an average of half a day's absence from work following an accident, it has been estimated that this would amount in factories alone to a loss of 700,000 worker-days per annum. Whatever may be the exact figure it is certain that quite trivial accidents may and do entail a heavy loss in production, so that it is worth while to keep accurate records in order to find out where, when, how and to whom, accidents occur.

Summary of Recommendations

(1) Set up proper safety organizations in factories where they may be lacking.
(2) Supervise the young and inexperienced workers.
(3) Keep the timing of machines as far as possible at a regular and optimum speed.
(4) Attend to the adequacy of lighting, heating and ventilation.
(5) Supervise medically the tired and sick workers.
(6) Make provision in dangerous departments for removal to safer positions of those who have shown themselves to be " accident-prone ".
(7) Keep accident records as an aid to revealing the conditions which favour accident causation.

V—SICKNESS ABSENCE AND LABOUR WASTAGE

Sickness Absence

Loss due to Sickness

During the last war the increase in sickness absence among munition workers became sufficiently serious to cause an inquiry: and in the report of the Health of Munition Workers Committee (1917) it is stated that the time lost through sickness was greatly under-estimated.

Since then, various attempts have been made to estimate the total loss to the country either in weeks of work or in money. One such estimate arrives at the figure of over thirty million weeks lost each year by the insured population, at a cost of about fifteen million pounds. Even these impressive figures do not represent the total loss, since absences of three days or less are not included. A recent report of the Department of Health for Scotland states that the average duration of incapacity in an insured population of about one-and-three-quarter million persons was approximately 15 days. Such figures, however, refer to the country as a whole and give no clue to the distribution of these lost days among different firms and occupations ; it is this that is important, because it is in individual firms that remedies can be applied.

In a survey of a number of industrial organisations made by the Industrial Health Research Board, and extending over a period of about ten years, it was found that there were considerable variations from one organisation to another and also from one department to another within the same organisation. The first survey revealed that some of the differences between one organisation and another were due to dissimilar methods of book-keeping. If a firm automatically excluded from its records workers who had been absent for more than a week or month, as the case might be, while another firm included all absence until the absentees returned or left, then obviously the sickness absence figures would not be comparable. Where conditions were strictly comparable, however, there still remained differences that were significant and important.

> *Example.*—One organisation, suspecting that the sickness absence was high, analysed the records and found that the men had an average of 11 days and the women of 17 days per annum. Inquiry revealed that some of this loss was preventable ; steps were taken to improve the conditions and the sickness absence fell to about 8 days and 11 days respectively for the men and women.

Where records are available for a number of years for the same organisation, it is found that there is very little difference from one year to another, so that—unless there is some special reason such as an epidemic—any sudden increase calls for investigation.

Absence Records

During a war it is essential that there should be no preventable loss. To ensure this means estimation of the actual loss, and this makes it necessary to keep accurate records of absence due to sickness as well as to accidents (see Section IV). A number of enlightened organisations have done this for years as part of their routine, believing that, by keeping as accurate records of the personnel as of the finance, they are in a position to find out at an early stage the effect of new processes or working conditions. The clerical work involved is not great. Usually the medical or welfare department or the personnel department is responsible, and various methods are in use. In some firms the head of each group of workers sends in to the department concerned a daily list of all those absent, and of absentees who have returned. The information about each worker is then entered on his card, and the duration of absence is calculated. In other firms a register is kept for each unit of workers and the absentees marked each day. At the end of some specified period, usually a month, a responsible person calculates the total loss; and then, according to the information required, the relation of the loss to age, to occupation, to duration of service, and so on. It is essential that all absence should be recorded, not only that for which benefit under the National Health Insurance Act has been paid. There are various types of cards available, of which the following is an example :—

Name............................	Date of Birth ....
Department........................	Date of Entry into Firm........
Occupation	Date of Leaving ....
Sex................................	Length of Service ....
	Cause of Leaving ....

First day of Absence.		Returned to Work.		Nature of Sickness.	Duration in working days.	Remarks.
Day of Week.	Date.	Day of Week.	Date.			

Calculating the Absence Rate

There are several ways of calculating sickness absence, but experience has shown that the simplest is to find out the total number of days lost through sickness during the selected period, and to divide this by the average number of people employed during that period.* Thus, if a staff of 400 men lost in a year 2,528 days, then 2,528/400 = 6·3 is the sickness rate per man per year. This is the most important rate to work out.

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* The calculation of the average number employed is not difficult for stable organisations. The number on the books at the beginning of the year, added to the number at the end of the year, divided by 2 gives a working figure, *e.g.*, if the staff on 1st January were 500, and on 1st December 560, then 500 + 560 = 1,060/2 = 530, would be the average number employed. When the numbers are rapidly increasing the average can be calculated from the number on the books on the first day of each month, added together and divided by twelve.

In stable organisations during normal periods the yearly figure is the one most commonly used, although for practical purposes weekly and monthly rates are often worked out. In rapidly expanding organisations it becomes advisable to calculate the weekly figure, and this is particularly useful during war-time.

Example.—A large organisation which had kept detailed records for years found at the beginning of the war that its absence rate was rising week by week. The medical staff watched carefully and, allowing for the general disturbed conditions, they found that a high percentage of this was due to a limited number of departments; the cause was found and remedied, with the result that a stable normal figure has now been reached.

The procedure for dealing with sickness absence varies from one organisation to another. In some there is a regulation to the effect that no one who has been absent for even a day can return to his department without first reporting to the medical department. Others look upon this as a waste of time. Actually it has been found to be a useful precaution, since it enables the doctor to verify that the worker is fit for work and it checks absence for trivial reasons.

Duration of Absence

So far, only absence in general has been considered, not its duration; the sickness rate does not show whether the figure is due to a few people having long periods of absence, or to large numbers having short spells. The one-day absence is the commonest type. This does not mean that it causes the greatest amount of sickness absence. In many cases it may, in fact, prevent longer sickness absence. But the frequent occurrence of absence from sickness in particular workers or groups of workers may be disproportionately disturbing to the work in hand. In such cases inquiries should be made, and it will often be found that some individual or group adjustment of working conditions may go far to eliminate an abnormal incidence of one-day sickness absence.

At the other end of the scale is the long period absence. An absence of 30 working days and over has been taken arbitrarily as a measure of long sickness absence. Roughly, less than 5 per cent. of the employees in the various organisations studied had illnesses of more than 30 working days, and they accounted on the average for about 39 per cent. of the total sickness loss although there was a wide range of variation.

Example of Method

Number on the staff = 722 men.

Total number of days lost in 1930 = 2,688.

Number of spells of one-day absence = 188.

Number having 30 days and over in one spell = 16, and these between them had 933 days.

Then 2,688/722 = 3·7 = average number of days per man.

16 out of 722, *i.e.* 2·2 per cent. have long sickness absence, and these account for 933 days out of the total of 2,688, *i.e.* 34·7 per cent.

In another group, 1·3 per cent. of the staff accounted for nearly 55 per cent. of the loss.

There were 188 spells of one-day absence, and this may be expressed as 188/722 = 0·26 per man.

Similarly, other rates could be worked out for different age groups, different occupations, different lengths of service, and so forth, according to the problem. But even the crude rate is useful, and—not even excepting output—it is the best method for measuring the well-being of a reasonably stable organisation. (If an organisation automatically dismissed its sick employees, then clearly it would have a low sickness rate, but it would also have a high labour wastage and would be far from stable.)

Medical Diagnoses

Over the greater part of industry no medical certificates exist for the shorter periods of absence, but where the firm has a medical staff or qualified welfare worker or nurse, the information can be obtained personally. This is easy for large organisations. Small firms cannot afford, and do not need, a whole-time doctor, but it should be possible to devise a co-operative local scheme, whereby the much-needed medical supervision could be shared.

In recent years some organisations have appointed medical officers whose duty it is :—

(*a*) to carry out the medical examination of new entrants so as to see that each worker is physically capable of undertaking his allotted task (thus supplementing a need long recognised by factory legislation, which requires young entrants under the age of 16 to be certified by the Examining Surgeon of the District as fit for the work they have to do) ;

(*b*) to see that workers selected as healthy (few firms have laid down definite physical standards) do not become less healthy from preventable working conditions ;

(*c*) to ensure that the sick receive adequate attention, and are allowed reasonable sick leave ;

(*d*) to supervise the first treatment of industrial injuries, to collaborate with outside doctors and hospital staffs in further treatment of the sick and injured, and to assist in their rehabilitation to work ;

(*e*) to watch sickness and accident rates and labour wastage as indices of health, and to advise the management where these rates appear unduly high.

It has been found that the most important cause of sickness absence is the disease group, influenza and cold. These are better classified together, although in fact not identical. At times all colds tend to be labelled influenza, and such variations as " influenzal cold," " cold and influenza," " catarrhal cold," and " catarrhal influenza," cannot be regarded industrially as important differentiations.

For practical purposes it will be found that the following groups account for the disabilities commonly affecting large numbers of people, in contrast to those of rarer incidence limited to a few isolated cases :—

(1) Colds and influenza, and the allied affections of tonsillitis, laryngitis, pharyngitis, bronchial catarrh, and sore throat.
(2) Accidents, both in and away from the works.
(3) Gastric affections, including dyspepsia, colic, biliousness.
(4) Rheumatism and allied affections.
(5) Nervous breakdown, neurasthenia, nervous debility, nervous exhaustion, or some other synonym.
(6) Septic conditions, carbuncles, ulcers, boils.
(7) Operations.
(8) Affections of the eyes, ears, or teeth.

Strictly speaking, the above is not a classification, but it is a useful grouping of the commoner diagnoses found in industrial organisations. As a result of analysing the records of a number of industrial organisations, it was found that the above accounted for over 70 per cent. of the total sickness absence in each organisation.

The following are useful alternative ways of calculating the relative importance of the various disease groups :—

(*a*) Calculate the number of days lost in each disease group and express this as a percentage of the total loss. Thus, if the total loss is 5,737 days, of which 1,909 days are due to colds and influenza, then 1,909 divided by 5,737 and multiplied by 100 gives the loss per 100 days for these disabilities, in this case = 33·3.

(*b*) Calculate the average number of days lost per person in respect of each disease group. Thus, if 1,909 days are lost through colds and influenza and the number employed was 679, then the rate for colds and influenza is 1,909/679 = 2·8 days per person.

Example

Analysis of all the medical diagnoses of an organisation employing 679 women, showing the number of days lost through sickness absence expressed (*a*) as a percentage of the total loss and (*b*) as the number of days lost per person ascribed to each disease group.

Diagnosis.	*No. of Days.*	(*a*)	(*b*)
Colds and influenza	1,909	33·3	2·81
Gastric affections	744	12·9	1·10
Tonsillitis	695	12·1	1·02
Gynaecological conditions ..	302	5·3	0·45
Rheumatism	296	5·2	0·44
Nerves	262	4·6	0·39
Accidents	242	4·2	0·36
Anaemia	209	3·6	0·31
Affections of the eyes and ears ..	205	3·6	0·30
Skin affections	184	3·2	0·27
Tuberculosis	149	2·6	0·22
Infections	145	2·5	0·21
Bronchitis	123	2·1	0·18
Pleurisy and pneumonia	107	1·9	0·16
Bronchial catarrh	97	1·7	0·14
Dental conditions	64	1·1	0·09
Organic nervous disease	4	0·1	0·00
Total	5,737	100·0	—
Number employed	679	—	—
Average number of working days lost per person		—	8·45

It will be noticed that colds and influenza with tonsillitis and bronchial catarrh, gastric affections, rheumatism, nerves, accidents, and affections of the eyes and ears, account for 77·6 per cent. of the total loss.

Labour Wastage

In all work other than that which is wholly unskilled, a high labour wastage is extravagant, since some time must elapse before entrants become efficient. If entrants do not remain a reasonable length of time, it may be that there is something wrong with their selection, or with their training after engagement, or with their physical or mental make-up. If a material number of workers remain for some time and then leave for other than special reasons, their general conditions of service have to be considered.

*Method of estimating wastage**

From the cards (see page 22) find out the number of men and of women who have left during the unit of time selected. Estimate the average number employed during the period, omitting both from the leavers and the number employed any persons appointed for a limited definite time. Divide the number of those who have left by the average number employed, and express the result as a percentage.

Example.

Period of time : 1st January to 31st December.

	Men.	*Women.*
Average number employed	316	964
Number left	43	226
Crude wastage rate	(43/316 × 100) = 13·6 p.c.	(226/964 × 100) = 23·4 p.c.

This is the most important rate to work out. It makes no allowance for age, length of service or occupation, but rates in respect of these can be worked out similarly.

The rates for different sections of an organisation should be calculated, and when it is found that the wastage is high in any particular section, a reason should be sought.

Where large numbers of entrants start work on the same date, it is useful to work out the rate of leaving week by week and follow up the same set of beginners for some months. An example of the simplest method of doing this may be given.

Example.

Suppose that 100 entrants begin on 1st January and that by the end of the first week 10 of them had left, then the wastage rate for that week is 10 per cent., and 90 of these remain for the next week. Then suppose that of these 90, 6 leave by the end of the second week, then the wastage rate for that week is 6/90 × 100= 6·7, leaving 84 to begin the third week. And so on, the results being tabulated as follows :—

Length of service in weeks.	No. present.	No. leaving.	The number leaving expressed as a percentage of those present.
0	100	10	10·0
1	90	6	6·7
2	84	5	6·0
3	79	6	7·6
4	73	4	5·5

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* There are various methods, each of which is useful for some purpose. There are also different meanings attached to the phrase "labour wastage."

Such a method shows exactly where the greatest loss occurs, and it also enables the firm to estimate how many ought to be appointed on a given date in order to guarantee a certain number at the end of three months or of six months, as the case may be.

Analysis of a number of organisations shows that in normal periods it is during the first month that the highest wastage occurs, and that the younger entrants are the more unstable. In a number of munition factories studied during the last war, the workers who left before serving a month ranged from about 7 per cent. to 11 per cent. of the entrants.

Reasons for a High Wastage Rate

It is impossible to give a complete list, but the following have been found to be important causes of wastage :—

1. Competition by different firms for a limited field of labour. This operates chiefly with juveniles in areas where there are several firms employing the same type of labour.
2. Poor selection by the firm.
3. Disagreeable conditions.
4. Too long hours.
5. Too much unrelieved routine.
6. Incompetent management.

Although it is impossible to fix definite standards, since there is considerable variation from one organisation to another, any sudden rise in the labour wastage rate should be investigated.

Summary

The lowest rates both of sickness absence and labour wastage are found in organisations where the working conditions are good, where the selection is adequate, where there is a reasonable chance of promotion, where the administrative staff understand the work and the workers, and where the organisation is stable but not rigid.

Full opportunities for the expression of grievances or complaints will prevent difficulties and misunderstanding, and in that way conduce to low sickness absence and wastage rates.

Recommendation

As with recorded output figures, recorded sickness absence and labour wastage figures reflect the effects of conditions of work on health. In a simple form such as outlined above, it is recommended that these records be kept. They are being kept by many industrial organisations, and arrangements for doing so are easy.

VI—CONCLUSION

In the preceding pages definite recommendations have been made. It is believed that their adoption would result in increased efficiency all round and in the increased health, both bodily and mental, which is the workers' main guard against discontent. Some of the recommendations made are more urgent and more immediately practicable than others: these include the recommendations made under Sections I, II and III.

It is not that others are less important. The information to be obtained from properly kept sickness-absence and accident records, for instance, can be of immense value as an index to efficiency: and it has been noted that in recent years a number of organisations have appointed medical officers, part of whose business it is to discover the amount and causes of sickness absence and accidents, and to advise on preventive measures. Whole-time medical supervision on the " industrial front " is more than ever necessary now.

Other important aspects of the Board's work have not been touched on, in particular the use of tests for general and specialised skills. At a time when there must of necessity be considerable and wide displacement of labour, and an unusual number of people have to learn new skills quickly, the importance of test methods is greater and not less than it is normally. There may be administrative difficulties in the application of the methods under present conditions of labour entry into industry, but those difficulties might not prove to be insuperable. In combination with reasonable and practicable training schemes, tests for general and special occupational aptitude would certainly do much to economise time and effort, to reduce the liability to fatigue, and to increase the general health and contentment of the workers. The War Office has, in fact, already accepted the Board's advice in the use of such tests to be given to recruits.

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